Availability of Mercury Control and Measurement Technologies

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Institute of Clean Air Companies

Virginia DEQ Mercury Symposium
Newport News, VA

Who Is ICAC?

- The National Association for Air Pollution Control Manufacturers
  - about 100 companies
  - ctive since 1960
- vide Information on the Capabilities o
  ution Control Technology and Sup
  - Federal, State and Local Regulatory Issue
  - Industry Trade Groups & Other Associatio
  - Public-At-Large
- Produce technical standards and white papers

What Do We Know about Controlling Mercury?

- Solutions come in different shapes and sizes
- Accelerated development of mercury control resulted from collaboration effo between industry, suppliers and R&
- Regulations create market certainty d R&D and commercial competition cost solutions
- Tremendous progress and investm made that resulted in better performanc lower costs

Mercury Control Evaluations: ACI Timeline

Pilot Testing

Full-Scale Testing

1991

EPRI: Comanche

1995

EPRI: Hudson

DOE/EPRI: Comanche

EPRI: Boswell, Sherco, Pleasant Prairie Nanticoke, Miller, Coal Creek, Others

DOE/EPRI: Valley, Powerton

2001

DOE Phase I: Pleasant Prairie, Gaston, Salem Harbor, Brayton Point)

EPRI: Abbott, Laskin, Stanton, Coal Creek

DOE Gaston

2004

DOE Phase II: Holcomb, Stanton, Yates, Meramec, Leland Olds, Laramie River, St. Clair, Buck, Monroe, Antelope Valley, Conesville, Independence, Big Brown, Council Bluffs,Louisa, Dave Johnston, Portland, Lee, Miami Fort

2006

Industry: Multiple

DOE EPRI: Presque Isle

DOE Phase III: rdin, Hawthorn, Mill Creek,

2007

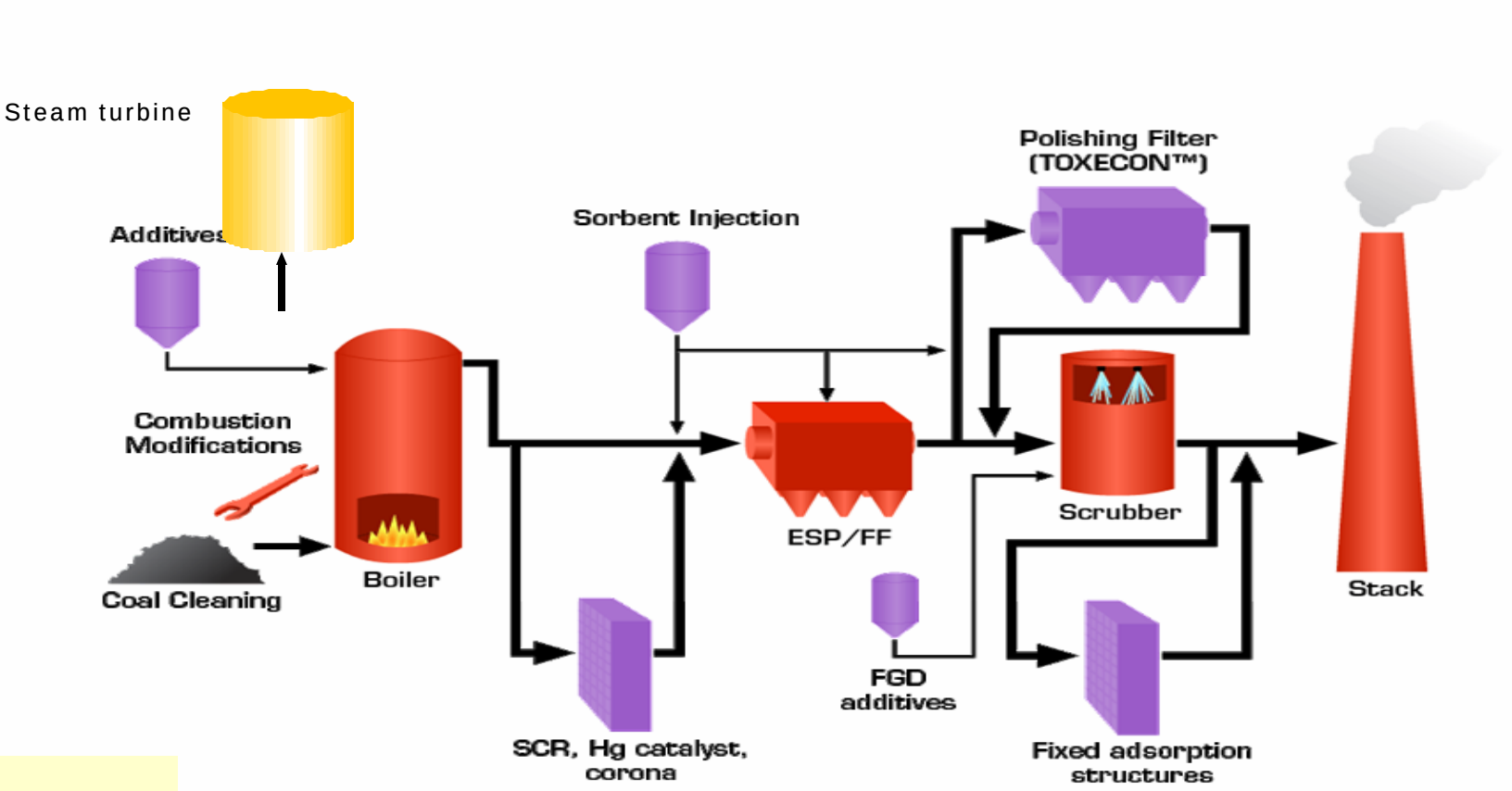
Commercial: 40+

Suite of Control Options

- Co-benefits
  - **SCR, FGD, ESP, FF, etc.**
- Enhanced co-benefits
  - **Chemical oxidants**
  - **Adding additional catalyst layers or new oxidizing catalyst**
- Sorbents
  - **Activated Carbon – Chemically Enhanced activated carbon**
  - **Non-carbon based sorbents**
- Combustion modifications
  - **In boiler modifications to oxidize mercury and increase amou carbon (i.e. research and demos at Lehigh University and GE**
  - **State-of-the-Science Ultra-Super Critical Boilers with a**
- Precombustion
  - **K-fuel : cost in scrubbing coal; can be combined with other c**
  - **Gasification: up front equipment cost to convert from soli fuel; requires pollutant disposal**

Integrated Coal-Fired Emission Controls

Pollutants: NO_x + SO_2 + Hg + PM + Condensables + CO_2
Post-Combustion Controls: SCR+ FGD + ACI + ESP/FF+ WESP + Scrubber



Some Bituminous Coal Control Strategies

Bituminous coals typically have moderate-high Cl/Br content and higher sulfur levels:

"the right stuff" for mercury and SO_2 control

Configuration

GD: ACI/PAC, and add fabric filter option if:

- **esire higher mercury removal efficiency, and**
- **ash sale**

Dry FGD: ACI/PAC (*may already have fabric*

Wet FGD: improve and control mercury oxidation

Co-Benefits/Multipollutant Approach – timing and labor

- Wet FGD:
  - 19 to 30 months to construct (avg. in mid-20's); 180 man-years
  - Components: grinding mill, slurry prep., reactor vessel, dewatering and gypsum stacking
- R:
  - 13 to 24 months to construct (avg. in low 20's); 17 years
  - Components: structural steel, NH_3 injection grid, catalyst reactor bed, catalyst, by-pass duct (?)

*** Need for early planning decisions**

Early Demo of Wet FGD Co-Benefit … Plus

Mount Storm Site Test (WV)

- **Eastern Bituminous Coal**
  - ✓ **medium sulfur (1.82%)**
  - ✓ **4,000 tons/day**
- **1662 MW (3 units combined)**
- **Air Pollution Controls**
  - ✓ **SCR – 2 layers**
  - ✓ **ESP**
  - ✓ **Wet FGD – forced oxidation limestone**

Results of Co-Benefit … Plus

71-78% mercury removal with only wet FGD
- **some mercury re-emission at outlet**

80% mercury removal with wet FGD plus additive (w/o SCR)
- **additive stopped mercury re-emission**
- **SO_2 removal by wet FGD system not impacted by additive technology**

90% plus mercury removal with wet FGD & SCR
- **>95% of mercury in oxidized state after SCR**
- **similar results with/without FGD additive (no mer emission to control)**

❖ Demonstrated improvements using wet FGD ad process (B&W patented sodium hydrosulfide)
- **Improved removal of mercury w/o SCR in-servi**
- **Cost-effective incremental mercury removal (w/o activated carbon injection)**

Capital Costs: Complying with New Emission Control Regulations

Regulation	Equipment	Capital Costs 500 MW Plant
SO_2/NO_x	FGD & SCR	$150 Millio
Mercury	ACI	$1 Millio

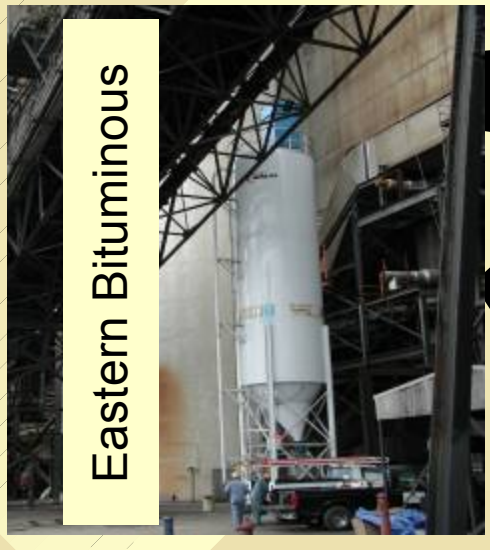
More than 70 Commercial Contracts for Mercury Specific Control Awarded to Date

- Booked for 29 GW of capacity – nearly 10% of total U.S. coal-fired capacity
- 8 Hg Control Systems Currently Operating
- Both on New Boilers and Existing Boilers
- Both Small and Large Applications; 75 – 800 MW
- Coal Types - Bituminous, Subbituminous, and Lignite Coals and Blends
- Broad Range of APC / Plant Configurations
- Full list of bookings at www.icac.com

- TOXECON
- SDA/FF
- ESP
- Multi-pollutant
- ESP/WFGD/WESP
- FT-SNCR/CDS/FF
- SCR/FF/WFGD
- SCR/FF/WFGD
- HS-ESP/FF/WFGD
- Cold-Side ESP

- Cold-Side ESP
- ESP/FF (TOXECON)
- SCR/FF
- ESP/FF
- ESP/FF Parallel Flow
- ESP/WFGD
- Lime Inj./ESP/WFGD/WESP
- CFB Boilers/SNCR/ACI/CDS-DFGD/FF

ACI Evaluations on Over 30 Units with Various Configurations



Extensive Data Collection and Analysis for Each Full-Scale Program

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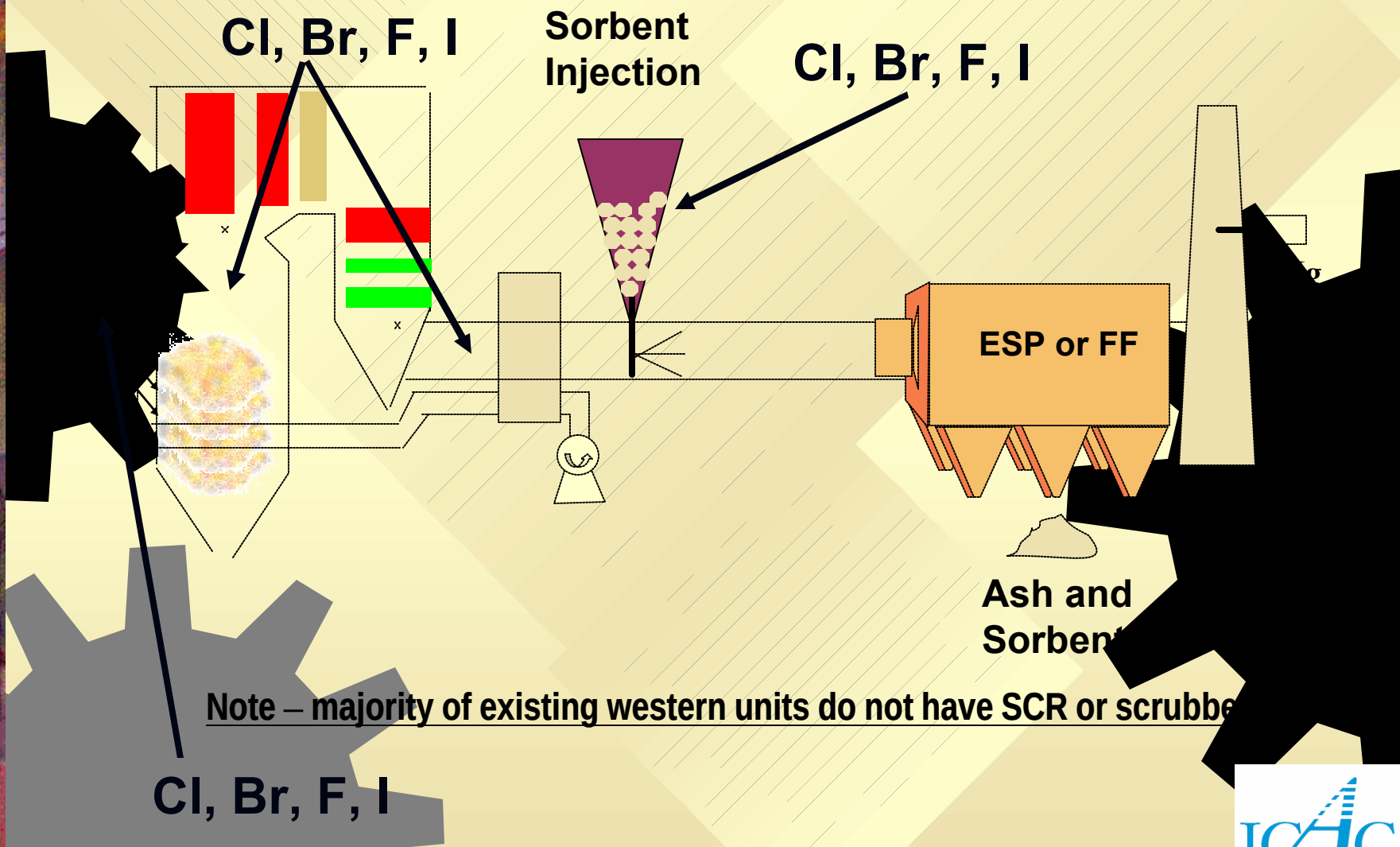
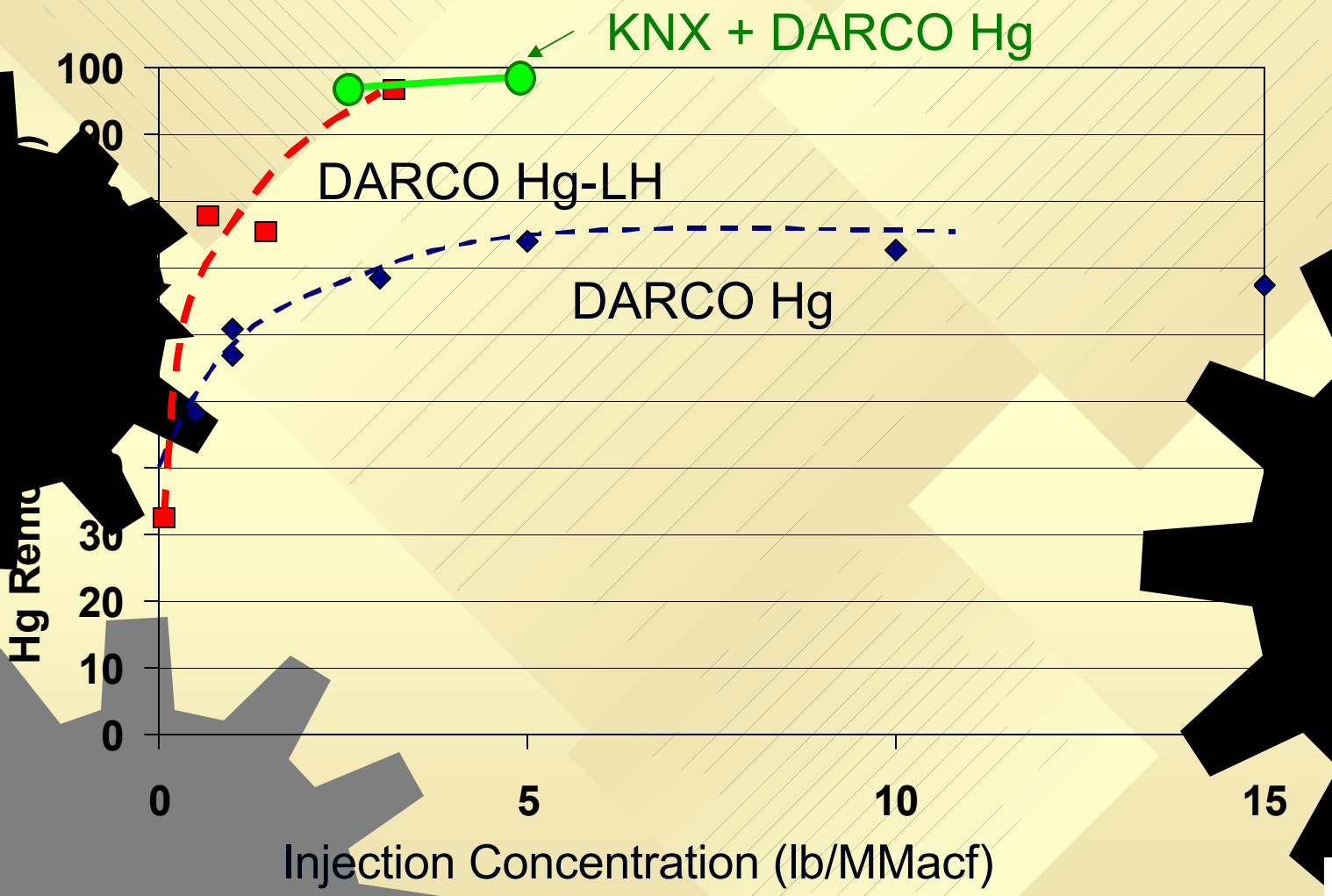
Enhancing Mercury Removal for Western Coals



Note – majority of existing western units do not have SCR or scrubbe

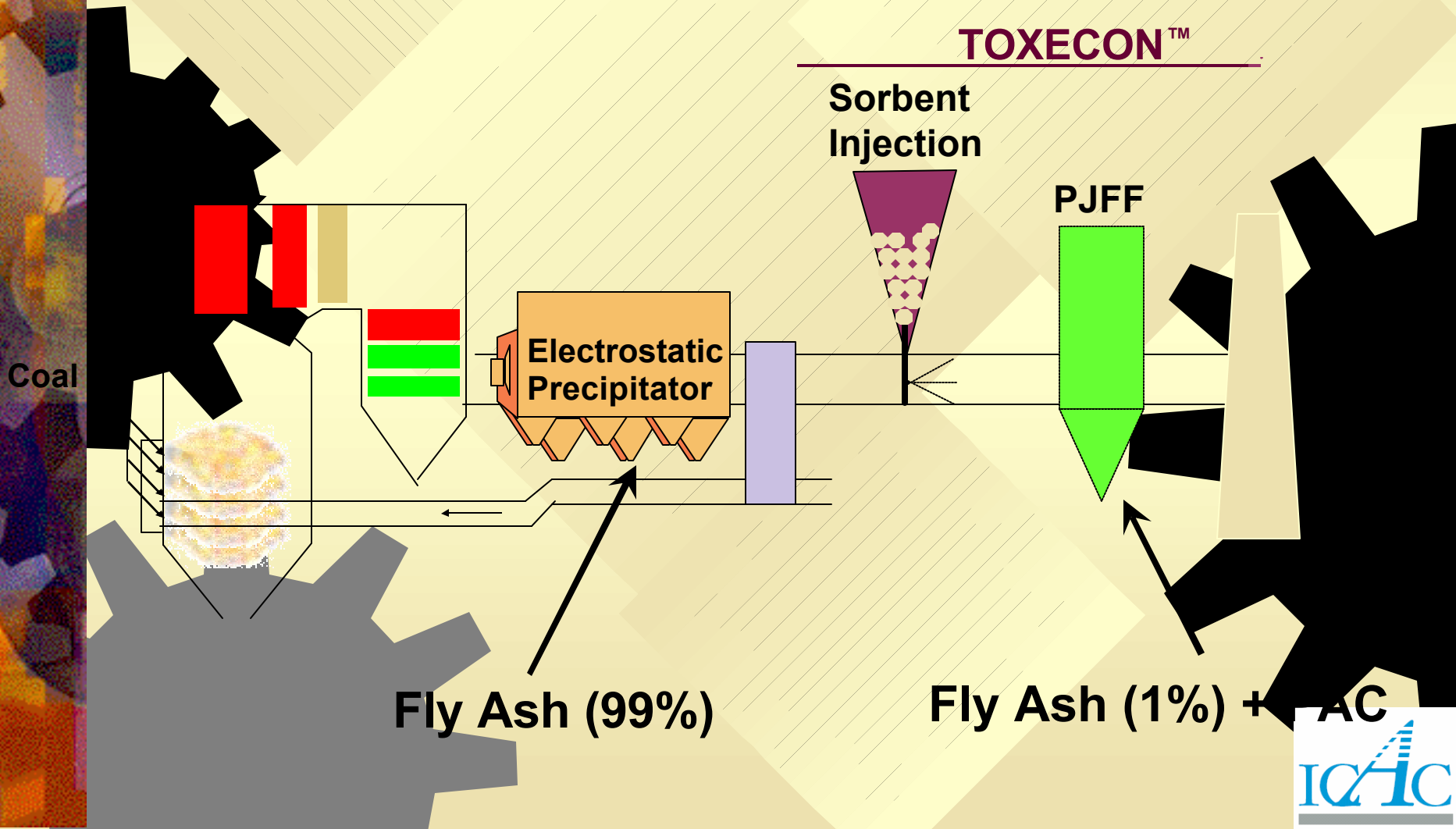
Coal Additives and Brominated AC on a PRB Unit with only an ESP



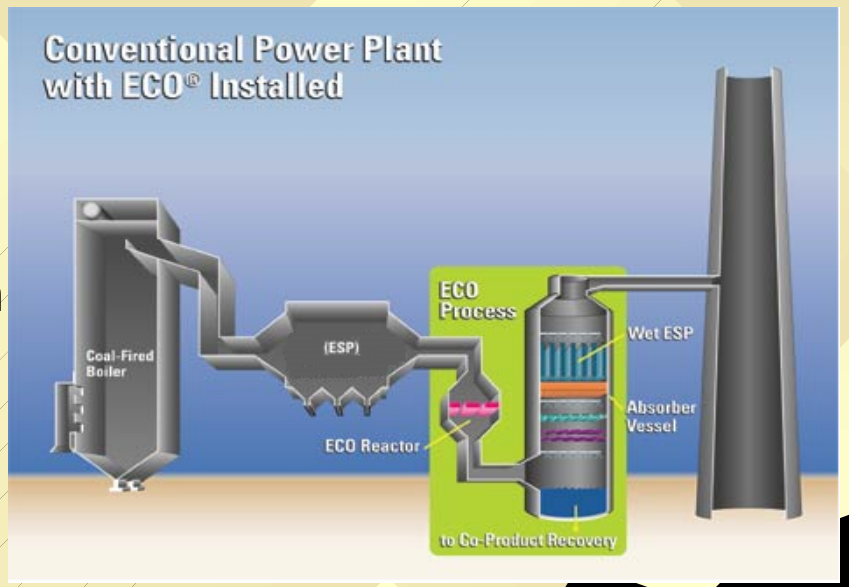
Ash Issues

- The mercury captured by PAC, LOI, and ash appears to be very stable and unlikely to reenter the environment.
- The presence of PAC will most likely prevent the sale of ash for use in concre
  - This will impact 30% of the units in the U.S.
- Several developing technologies to address the problem:
  - Separation
  - Combustion
  - Chemical treatment
  - Non-carbon sorbents
  - Configuration solutions such as EPRI TOXECON

EPRI TOXECON™ Configuration



Additional Multipollutant Control Options



Powerspan ECO Process

- **Integrated Control Approach**
- **High Energy Corona**

OXECON II

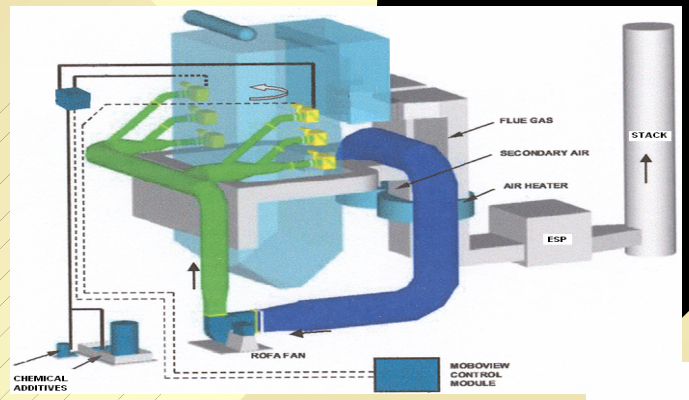
- **id-ESP PAC Injection**
- **aintain Ash Sale Ability**

Rofa & Rotamix Technologies

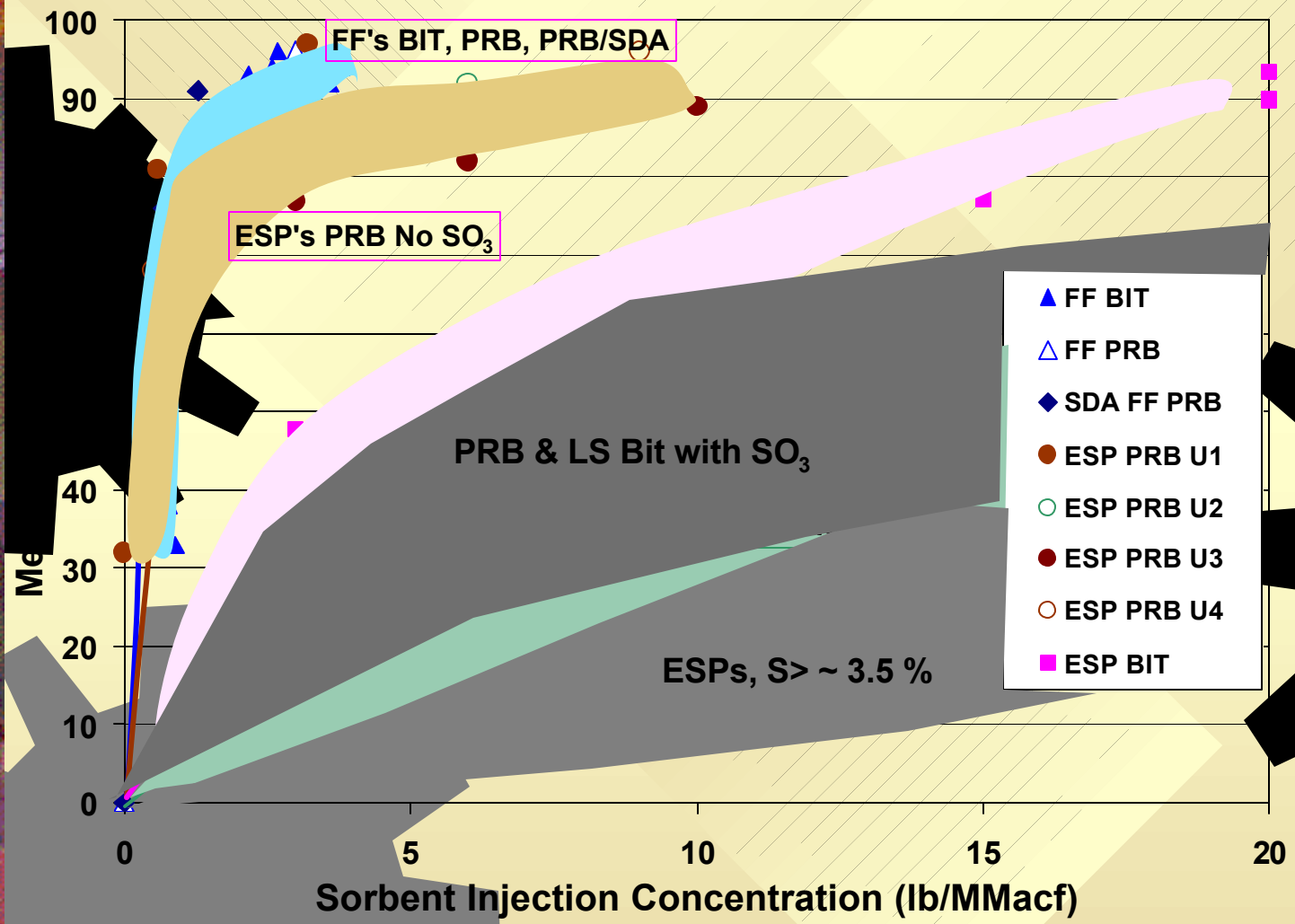
- **MINPlus - Sorbent Injection in Boiler**
- **Scrubber After Boiler**

Evergreen (KFx) K-Fuel Process

- **Coal Cleaning**
- **High Temp. and Pressure**
- **Western Low Btu Coals**



Summary of Mercury Control with PAC

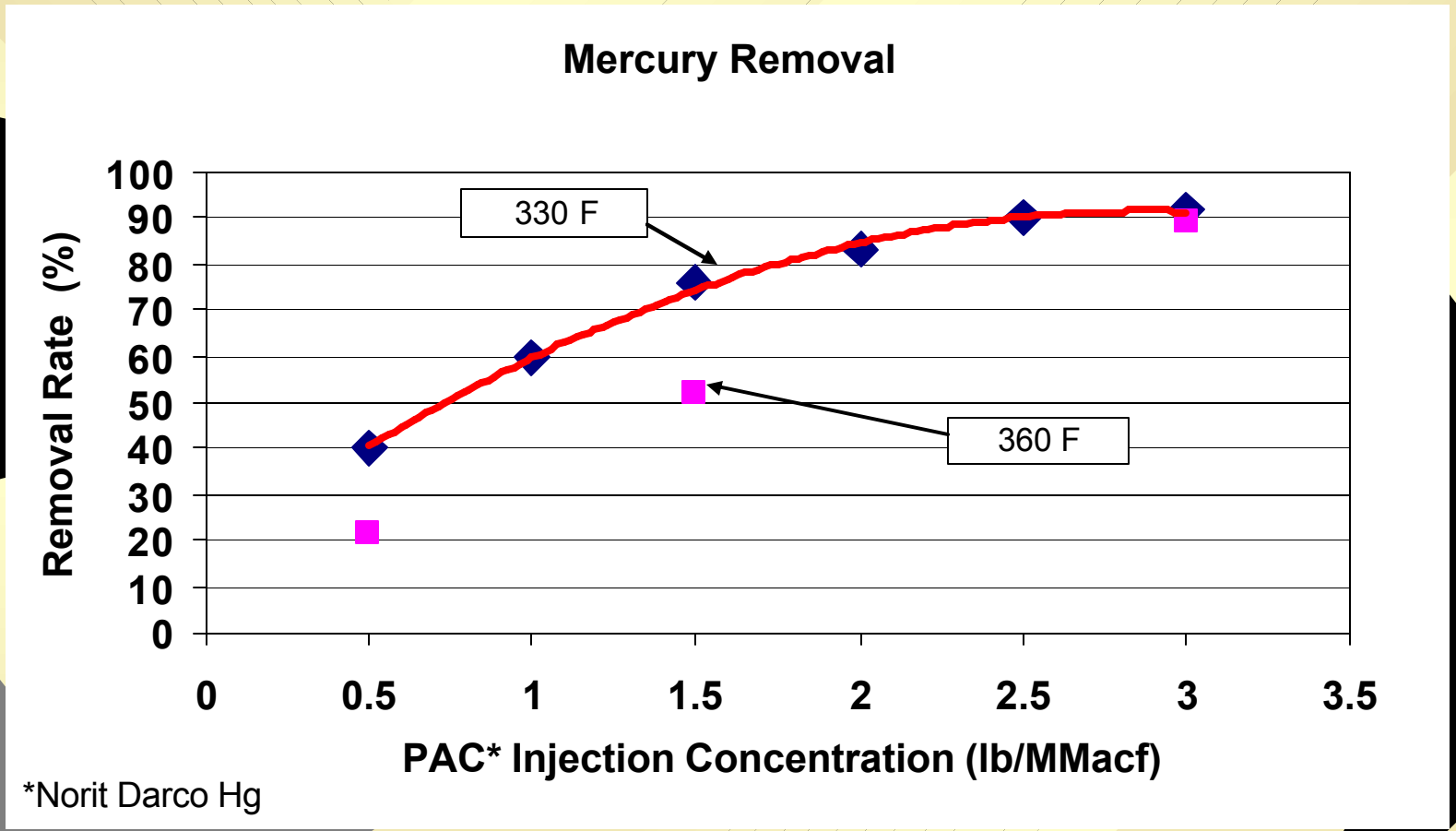


1st Commercial Mercury Control System TOXECON ä – 270 MW Demonstration

- Clean Coal Program – We Energies and DOE
- esque Isle Power , Marquette MI
- nits 7-9
- RB Coal from Antelope and Spring Creek Mines
- $53.3M
  - $24.9M DOE
  - $28.5M We Energies

TOXECONä Mercury Control Equipment

Preliminary Results from Presque Isle TOXECONÔ



*Norit Darco Hg

Note – Achieved 90% or greater mercury removal for 28 continuous days

Preliminary Results from Presque Isle TOXECONÔ

- Operational Issues
  - **Hopper Fires**
  - **Hopper Rat-Holing**
  - **Material Handling-Dusting**
  - **Bag Cage Separation**
  - **Condensation At Start-up**
  - **High Flue Gas Temp Reduces Hg Removal Efficiency**

Regulatory Framework for Rapidly Developing Technology

"How to Maximize Environmental Benefits Without Posing a Threat to Generation?"

Account for Plant by Plant Variations in Cost and Performance

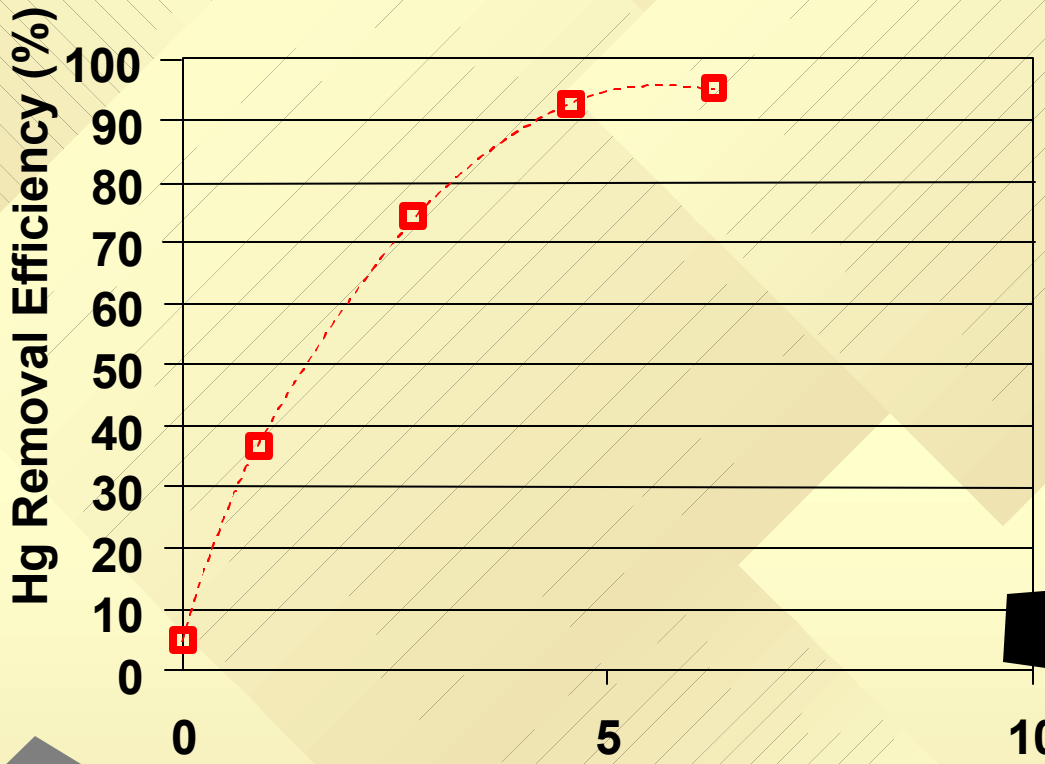
- **Fabric Filters:**
  - Most predictable performance
  - Current range 85-95%
  - With proper design 90%+ is readily achievable.
- **ESPs:**
  - Every ESP operates differently
  - Current range of performance 70-90%

Encourage Early Adoption

- Economic incentives for early compliance are needed to offset risks with new technology
- Early installations allow users and vendors to gain additional experience operating the technology, documenting performance and addressing any issues that may arise
- A regulation that provides a ramping of installations overcomes concerns with supply of materials and labor

Setting Lower Achievable Limits Early Can Lead to Greater Reductions Later

ACI System for 70% Control



ACI System for 90% Control

Examples of Regulatory Flexibility in a Mercury Rule

- **Account for differences in costs and performance**
  - NACAA (STAPPA/ALAPCO) Model Rule: Averaging among fleet
  - Georgia: Intra-State averaging
  - Illinois: Soft-landing provision
  - Minnesota: Different time-lines for wet scrubbers
- **Encourage early adoption**
  - Georgia: Banking provisions
  - New Hampshire: Banking provisions
- **Two-phase standard**
  - NACAA Model Rule
  - Massachusetts
  - Pennsylvania
  - Wisconsin
  - Georgia

General Improvements for Mercury Control

- Techniques to enhance and control mercury oxidation
- Techniques to minimize re-emission
- Potential impacts on by-products
- Less capital intensive techniques
- Cost of mercury removal is coming down

Continuous Emissions Monitoring

- Continuous Hg measurements are being made today
  - **Multiple suppliers of instruments**
  - **Technology rapidly advancing toward increased reliability and less frequent maintenance so it could be operated by plant personnel**
  - **EPA working on mercury gas generator certification**
- pliance and/or real-time control informat
- arbon canister (Appendix k) available for proc and compliance measurement

* *CEMS that have passed RATA are at least as accurate as the reference method*

Conclusions

- There will be significant plant-to-plant variations in costs to control mercury emissions
- lexibility in the regulation is critical to aximize mercury removal while minimizi y APC retrofit impacts on the aging coal-fired boilers in the US
- Technology rapidly improves result better performance at lower costs
- Commercial mercury control systems are available from a number of suppliers

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